

# COMBUSTION

## Project Fact Sheet



## MINIMIZING NO<sub>x</sub> EMISSIONS FROM BY-PRODUCT FUELS IN STEELMAKING

### BENEFITS

- Increase environmental desirability of using steel industry by-product fuels
- Enable integrated steel mills to meet their air emission permit targets more easily and at no increased cost
- Maintain industry competitive posture by reducing cost of purchased fuels

### APPLICATIONS

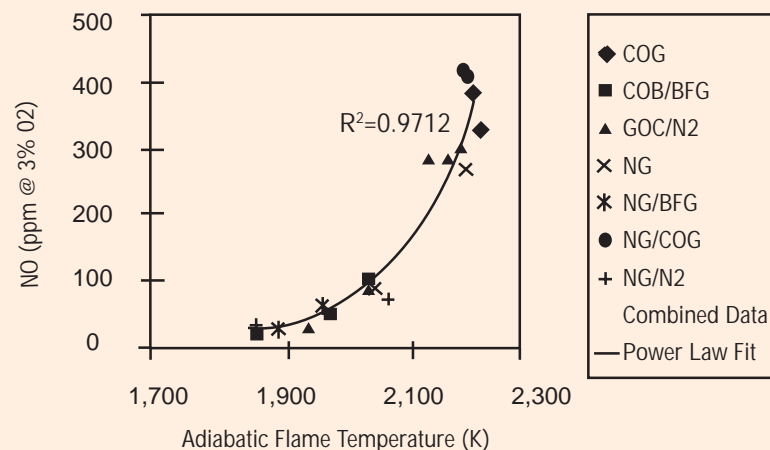
COG individually and in combination with natural gas is used as a fuel in steel reheat and annealing furnaces. While use of COG reduces the use of natural gas, higher emissions of NO<sub>x</sub> may result. BFG is used as a component in the fuel that is fed to blast furnace stoves and to process boilers. This BFG utilization cuts down on the fuel required to operate these processes. Research conducted by this project has found that blending COG with BFG reduces NO<sub>x</sub> emissions from furnaces, boilers and the other processes that use COG.

### NO<sub>x</sub> EMISSIONS FROM BY-PRODUCT FUEL COMBUSTION MAY BE REDUCED THROUGH DESIGN MODIFICATIONS, WHICH RESULT IN LOWER PEAK COMBUSTION PARAMETERS

The utilization of the by-product fuels, blast furnace gas (BFG) and coke oven gas (COG), in the steel industry dates back to the 1850s. Recycling these gases represents a way of reducing waste gas emissions and reducing costs associated with using standard fuels, such as natural gas and coal. However the combustion of these fuels, individually or in combination with natural gas, may lead to increased NO<sub>x</sub> emissions relative to natural gas combustion.

NO<sub>x</sub> emissions from the combustion of BFG and COG are closely characterized by adiabatic flame temperature. Therefore, burner and/or furnace modifications designed to lower peak flame temperatures allow for utilization of these fuels at lower NO<sub>x</sub> emissions levels.

### BFG AND COG EXPERIMENTS



**Summary of the results of experiments performed using simulated, dry gas mixtures of BFG and COG prepared from average compositions.**



## Project Description

**Goal:** Provide an understanding of the mechanisms controlling the formation of NO<sub>x</sub> emissions during the combustion of steelmaking by-product fuels, and investigate possible low-cost control options to minimize the NO<sub>x</sub> emissions.

NO<sub>x</sub> emissions from the combustion of by-product fuels are controlled by the thermal-NO<sub>x</sub> mechanism. NO<sub>x</sub> emissions from the combustion of COG and blends of COG and natural gas are elevated relative to natural gas alone due to the hydrogen and carbon monoxide content of COG. These components have adiabatic flame temperatures that are higher than that of natural gas. Thus, the combustion of COG and its mixtures results in higher peak flame temperatures and elevated NO<sub>x</sub> formation levels.

Blast furnace gas is greater than 50% nitrogen. Fuel blends with BFG result in lower peak flame temperatures due to dilution with nitrogen.

## Progress and Milestones

- Defined range of typical COG and BFG compositions, and typical usage practice.
- Determined NO<sub>x</sub> emission levels from different areas in steel making.
- Performed pilot-scale experimental studies utilizing the by-product gases.
- Performed companion modeling studies to verify conclusions from the experimental results.



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